

CONFIDENTIAL

CONFIDENTIAL

50X1-HUM

In most of the areas under investigation, frost is observed between November and March. However, in the piedmont and mountain zones the glaze frost period lasts from October to April. Similar phenomena are also noted in the central part of the Stavropol' Plateau. In the high mountain zone, the period during which glaze frost is observed extends to the summer months. For example, in the region of the Bermamyt Meteorological Station, frost is observed from April to November; in the region of Mamisson Pass, from June to November; and incomplete observations of the high-altitude El'brus Meteorological Station show signs of glaze frosts between July and October.

The following table presents in detail the characteristic yearly period of frosts for different regions of the area according to observations over many years.

<u>Meteorological Sta</u>	<u>Period of Glaze Frost in the Region of the Sta</u>	<u>Mo of Max No of Glaze Frost Occurrences</u>
Novo-Aleksandrovskaya	December - February	February
Molotovskoye	November - March	January
Divnoye	November - March	January
Voroshilovsk	October - April	January
Petrovskoye	November - March	January
Novoselitskoye	October - March	January
Budennovsk	November - March	January
Achikulak	November - March	January
Cherkessk	October - April	January, March
Kislovodsk	November - March	December
Mineral'nyye Vody	November - April	January
Stepan Bugor	November - March	February
Terekli Mekteb	November - February	February
Kizlyar	November - April	February
Teberda	December	-
Nal'chik	November - April	January, February
Groznyy	November - March	January
Bermamyt	September - July	May
Mamisson	June - November	September
Shatoy	December - April	December
Nizhniy Zaromag	December - April	March

In the majority of places, most glaze frost occurrences take place in January. At other places, the maximum number of frosts occur in February or even March. This is at variance with other regions of European USSR, where the maximum number of glaze frosts generally occur in December, and is probably due to the later onset of lower temperatures and of synoptic conditions favorable for the formation of glaze frost.

Average Annual Number of Glaze Frost Occurrences

[All figures are as given in text]

<u>Sta</u>	<u>No of Yr of Obs</u>	<u>Glaze Frost Occurrences (by months)</u>							<u>Total Glaze Frost Occurrences</u>
		<u>I</u>	<u>II</u>	<u>III</u>	<u>IV</u>	<u>X</u>	<u>XI</u>	<u>XII</u>	
Arkhyz	8	0	0	0	0	0	0	0	0
Arzgir	15	2	1	0	0	0	0	1	4
Apollonskaya	12	3	3	2	0	0	1	2	13
Aleksandrovskaya	14	3	2	1	0	0	1	2	8
Alagir	10	1	1	0	0	0	0	1	4

- 2 -

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

50X1-HUM

Sta	No of Yr of Obs	Glaze Frost Occurrences (by months)							Total Glaze Frost Occur- rences
		I	II	III	IV	X	XI	XII	
Achikulak	13	2	2	0	0	0	0	2	6
Armkhil	7	0	1	0	0	0	0	1	2
Baksan	14	3	3	2	0	0	1	3	11
Blagodarnoye	15	1	1	0	0	0	0	1	4
Bogoslovskaya	8	1	1	0	0	0	0	1	3
Bol'shaya Dzhalga	14	1	1	0	0	0	1	2	5
Budennovsk	15	2	1	0	0	0	1	1	7
Vedeno	14	0	1	1	0	0	1	2	3
Voroshilovsk	15	2	2	2	0	0	1	2	10
Georgiyevsk	14	4	3	2	0	0	1	2	13
Groznyy	15	2	1	1	0	0	0	2	7
Gudermes	11	3	2	1	0	0	1	2	8
Divnoye	15	2	1	0	0	0	0	2	6
Dargavs	14	0	0	0	0	0	0	0	0
Digora	12	1	1	0	0	0	1	1	4
Yessentuki	15	2	1	1	0	0	1	2	7
Zheleznovodsk	9	2	3	2	0	1	1	2	12
Zolotushka	13	1	1	1	0	0	1	2	6
Zamankul	12	0	1	0	0	0	0	0	2
Ipatovo	14	0	0	0	0	0	0	0	2
Kian	12	3	2	2	0	0	1	2	9
Kizlyar	13	1	2	0	0	0	0	1	4
Kislovodsk	15	0	0	0	0	0	0	1	2
Kotlyarevskaya	13	2	2	1	0	0	1	1	6
Kursavka	14	2	1	1	0	0	1	2	8
Mikoyan-Shakhar	8	2	1	0	0	0	0	0	3
Mineral'nyye Vody	15	4	3	2	0	0	1	2	14
Mozdok	11	3	3	1	0	0	0	0	9
Molotovskoye	15	1	0	0	0	0	0	1	2
Mikhaylovskaya	9	1	2	1	0	0	1	2	7
Murtazovo	13	3	1	1	0	0	0	1	6
Naurskaya	15	3	2	0	0	0	0	1	7
Nevinnomysskaya	15	0	0	0	0	0	0	0	1
Nizhn. Uchkulan	8	0	0	0	0	0	0	0	0
Novo-Aleksandrovskaya	12	0	0	0	0	0	1	2	0
Novoselitskoye	14	3	3	1	0	0	0	0	11
Nizhn. Zaromag	9	0	0	0	0	0	0	0	0
Fort Nazran'	8	0	0	0	0	0	1	1	3
Nal'chik	15	3	3	3	1	0	1	3	14
Ol'gino	15	4	2	1	0	0	1	2	10
Ordzhonikidze	15	1	1	1	0	0	1	2	5
Petrovskoye	15	1	1	0	0	0	0	1	2
Pyatigorsk	15	3	3	2	1	0	1	2	12
Prokhladnaya	10	2	0	0	0	0	0	1	3
Stepan Bugor	11	2	3	1	0	0	0	1	7
Sleptovskaya	15	2	1	1	0	0	0	2	6
Tambukanskoye Lake	13	1	1	1	0	0	1	1	6
Teberda	15	0	0	0	0	0	0	0	0
Tempel'gof	13	2	1	1	0	0	1	2	6
Terekli Mekteb	12	1	2	0	0	0	0	0	3
Trunovskaya	15	1	0	0	0	0	0	1	2
Usnegi	11	0	0	0	0	0	0	0	0
Fasnal	8	0	0	0	0	0	0	0	1
Khutor Russkiy	15	4	3	2	0	0	1	3	13
Tsey	10	0	0	0	0	0	0	0	0
Chervlennaya	9	3	4	1	0	0	0	1	9
Cherkessk	12	1	1	1	0	0	1	1	6
Shatoy	14	0	0	0	0	0	0	0	1
Shelkovskaya	7	3	1	0	0	0	0	1	6

- 3 -

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

50X1-HUM

Sta	No of Yr of Obs	Glaze Frost Occurrences (by months)							Total Glaze Frost Occur- rences
		VI	VII	VIII	IX	X	XI	XII	
Mamisson Pass	8	0	0	0	0	0	0	0	1
		IV	V	VI	IX	X	XI		
Bermamyt	6	1	1	1	1	1	0		4

Sta	No of Yr of Obs	No of Days With Glaze Frost (by months)							Total Glaze Frost Occur- ences
		I	II	III	IV	X	XI	XII	
Arkhyz	8	0	0	0	0	0	0	0	0
Arzgir	15	2	1	0	0	0	0	2	6
Apollonskaya	12	7	5	2	0	0	1	4	22
Aleksandrovskaya	14	6	2	1	0	0	1	3	13
Alagir	10	2	2	1	0	0	1	1	7
Achikulak	13	3	2	1	0	0	0	2	8
Armghi	7	0	1	0	0	0	0	1	2
Baksan	14	5	5	3	0	0	1	5	20
Blagodarnoye	15	4	1	0	0	0	1	3	8
Bogoslovskaya	8	1	1	0	0	0	0	1	4
Bol'shaya Dzhalga	14	2	1	0	0	0	1	3	7
Budennovsk	15	3	2	0	0	0	1	2	9
Vedeno	14	0	1	1	0	0	1	1	4
Voroshilovsk	15	4	2	2	0	0	2	3	14
Georgiyevsk	14	6	4	2	0	0	1	3	16
Groznyy	15	4	2	1	0	0	0	3	10
Gudermes	11	3	2	1	0	0	1	2	9
Divnoye	15	4	1	0	0	0	1	2	8
Dargavs	14	0	0	0	0	0	0	0	0
Digora	12	1	1	0	0	0	1	1	4
Yessentuki	15	3	2	2	0	0	2	3	12
Zheleznovodsk	9	7	6	4	1	1	4	7	31
Zolotushka	13	2	2	2	0	0	1	5	13
Zamankul	12	1	1	0	0	0	0	1	2
Ipatovo	14	0	0	0	0	0	0	1	2
Kian	12	3	2	2	0	0	1	2	9
Kizlyar	13	2	3	0	0	0	0	1	7
Kislovodsk	15	0	0	0	0	0	0	1	3
Kotlyarevskaya	13	3	2	1	0	0	1	1	8
Kursavka	14	4	2	1	0	0	1	3	13
Mikoyan-Shakhar	8	2	1	0	0	0	0	1	4
Mineral'nyye Vody	15	8	4	3	0	0	2	4	22
Mozdok	11	4	4	1	0	0	1	3	13
Molotovskoye	15	1	0	0	0	0	0	1	2
Mikhaylovskaya	9	2	2	1	0	0	1	2	7
Murtazovo	13	3	1	1	0	0	0	2	7
Naurskaya	15	4	2	0	0	0	0	2	9
Nevinnomysskaya	15	0	0	0	0	0	0	0	1
Nizhniy Uchkulan	8	0	0	0	0	0	0	0	0
Novo-Aleksandrovskaya	12	0	0	0	0	0	0	0	1
Novoselitskoye	14	9	7	1	0	0	2	5	24
Nizhniy Zaromag	9	0	0	0	0	0	0	0	0
Fort Nazran'	8	0	1	0	0	0	1	2	3
Nal'chik	15	5	5	3	1	0	1	4	20
Ol'gino	15	6	4	1	0	0	1	4	16

- 4 -

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

50X1-HUM

Sta	No of Yr of Obs	No of Days With Glaze Frost (by months)							Total Glaze Frost Occur- rences
		I	II	III	IV	X	XI	XII	
Ordzhonikidze	15	1	2	2	1	0	1	2	8
Petrovskoye	15	1	1	0	0	0	0	1	3
Pyatigorsk	15	5	4	3	1	0	1	4	18
Prokhladnaya	10	4	0	0	0	0	0	3	8
Stepan Bugor	11	4	4	1	0	0	1	3	11
Sleptovskaya	15	3	2	1	0	0	0	2	8
Tambukanskoye Lak	13	1	2	1	0	0	2	2	9
Teberda	15	0	0	0	0	0	0	0	0
Tempel'gof	13	3	1	1	0	0	1	2	8
Terekli Mekteb	12	1	2	0	0	0	0	1	4
Trunovskaya	15	2	1	0	0	0	0	1	4
Usengi	11	0	0	0	0	0	0	0	0
Fasnal	8	0	1	0	0	0	0	0	1
Khutor Russkiy	15	7	6	2	0	0	1	5	20
Tsey	10	0	0	0	0	0	0	0	0
Chervlennaya	9	4	5	1	0	0	1	1	12
Cherkessk	12	2	1	2	0	0	1	1	7
Shatoy	14	0	0	0	0	0	0	0	1
Shelkovskaya	7	4	2	0	0	0	0	1	8
		VI	VII	VIII	IX	X	XI	XII	
Mamisson Pass	8	0	0	0	0	0	0	0	2
		IV	V	VI	IX	X	XI		
Bermamyt	6	1	1	1	1	1	1		5

Note: 0.5 and fewer occurrences of frost are rounded to zero.

The above table shows that the frequency of glaze frosts for the areas of Ordzhonikidze Kray, Chechen-Ingush ASSR, North Osetian ASSR, and Kabardinian-Balkar ASSR differ considerably. At one extreme, in some regions the average annual number of glaze frost occurrences and days with glaze frost are close to zero, while at the opposite extreme, there are regions where the average annual number of days with glaze frost is as high as 20-25, and even 30 or more, days.

The area as a whole can be divided into the following rather characteristic regions:

1. The high altitude, mountainous region in the south and southwestern area (Arkhyz, Teberda, Uchkulan, Nizhniy Zaromag, Armkhi, and others) and the northernmost region (Molotovskoye region) where frost is rarely observed and where the average annual number of days with glaze frost is zero to 2 days.
2. The Terskiy-Kum lowlands (a large part of Kizlyarsk district), the mountainous part of Karachaya and of Kabardinian-Balkar and North Osetian ASSRs, where glaze frost is infrequent and where in most places the annual number of days with glaze is 4-5, with 7-8 days the total in a few localities.
3. The piedmont section of the Stavropol' Plateau; part of the Caucasian Mineral'nye Vody region, where the annual number of days with glaze frost is 10-15' and the regions of Baksan, Nal'chik, Yessentuki, Georgiyevsk, Pyatigorsk, Voroshilovsk, Kursov, where the annual total for days with frost is 15-20 days.

- 5 -

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

50X1-HUM

4. The Zheleznovodsk, Mineral'nyye Vody, and Novoselitskoye regions, where annual frost occurrences and average annual number of days with glaze frost very often exceed 20 days and even reach 31 days in the Zheleznovodsk region.

Local microclimatic peculiarities, as well as the nature of the location of the observation points, have a bearing on the number of days with glaze frost reported. Meteorological stations which are placed in closely sheltered locations show a much lesser number of days with glaze frost and glaze frost occurrences in comparison with stations which are located in the open or in rather exposed places. The meteorological data on the Pyatigorsk Meteorological Station, which was moved from the city of Pyatigorsk to Mashuk Mountain in 1936, illustrates meteorological changes caused by local factors.

Average Annual Number of Days With Glaze Frost

	<u>1925-29</u>	<u>Periods 1930-34</u>	<u>1935-39</u>
Pyatigorsk	11.4	8.8	32.3
Mineral'nyye Vody	--	31.6	37.0
Yessentuki	12.2	10.4	16.4

A comparison with data of the Mineral'nyye Vody and Yessentuki meteorological stations shows that the sharp increase in the number of days with glaze frost at Pyatigorsk during the 5-year period, 1935 - 1939, must have been due to the change in the location of the meteorological station in Pyatigorsk.

Most meteorological stations show dissimilarities in series of observations. This is due to the fact that glaze frost occurrences and days with glaze frost are given in whole numbers in the above table of average annual frequency of glaze frosts, inasmuch as computations with fractions expressed in tenths would represent a fictitious accuracy. The principal reasons for dissimilarities in series of observations are the result of: progress in the work of meteorological stations over the past 10 years; increased qualifications of observers; systematic control by the Administration of Hydrometeorological Service over the work of the stations; the introduction in the majority of stations of 24-hour duty for observers. These factors are the primary reason why the average annual total figures used in this paper differ considerably from the data in papers published previously.

A survey of the yearly observations of glaze frost shows that in some years the number of glaze frost occurrences and days with glaze frost can be quite different from the average annual figure. The minimum, even in regions which ordinarily have numerous occurrences of glaze frosts, is zero in some years. For example, in Mineral'nyye Vody the annual number of days with glaze frost was two in 1928 - 1929; in Voroshilovskoye it was zero in 1926; in Zheleznovodsk it was zero in 1932; in Groznyy it was zero in 1939; in Nal'chik it was 4 in 1925; and in Divnoye it was zero in 1938.

The following table shows the maximum annual frequency of glaze frost occurrences and days with glaze frost during 1925 - 1939.

- 6 -

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

50X1-HUM

Maximum Yearly Number of Glaze Frost Occurrences and Days With Frost

Sta	Glaze Frost Occurrences	Days With Glaze Frost	Sta	Glaze Frost Occurrences	Days With Glaze Frost
Arkhyz	1	1	Naurskaya	12	17
Arzgir	12	17	Nevinnomyskaya	5	6
Apollonskaya	23	45	Nizhniy		
Aleksandrovskaya	16	22	Uchkulan	2	2
Alagir	10	23	Novo-Aleksandrovsk	1	3
Achikulak	12	14	Novoselitskoye	27	37
Armkhi	3	5	Nizhniy		
Baksan	21	43	Zaromag	0	0
Blagodarnoye	8	18	Fort Nazran'	8	11
Bogoslovskaya	7	9	Nal'chik	25	30
Bol'shaya Dzharga	9	17	Ol'gino	18	57
Budennovsk	12	16	Ordzhonikidze	9	15
Vedeno	7	8	Petrovskoye	5	8
Voroshilovsk	19	31	Pyatigorsk	37	55
Georgiyevsk	26	37	Prokhladnaya	8	18
Groznyy	15	21	Stepan Bugor	14	41
Gudermes	10	14	Sleptsovskaya	15	17
Divnoye	12	20	Tambukanskoye Lake	11	15
Dargavs	2	2	Teberda	1	1
Digora	5	8	Tempel'gor	12	17
Yessentuki	12	23	Chervlennaya	15	22
Zheleznovodsk	22	53	Trunovskaya	6	14
Zolotushka	14	49	Usengi	1	1
Zamankul	4	9	Fasnal	2	2
Ipatovo	4	6	Khutor		
Kian	16	18	Russkiy	28	42
Kizlyar	11	22	Tsey	0	0
Terekli Mekteb	7	8	Cherkessk	14	19
Kislovodsk	6	8	Shatoy	3	3
Kotlyarevskaya	11	22	Shelkovskaya	20	31
Kursavka	16	33	Bermamyt	6	10
Mikoyan-Shakhar	7	9	Mamisson Pass	4	5
Mineral'nyye Vody	27	42			
Mozdok	21	27			
Molotovskoye	6	7			
Mikhaylovskaya	17	17			
Murtazovo	16	16			

The average duration of glaze frost occurrences in the area fluctuates from one to 25 days depending on the station's location.

Since a great deal of subjectivity on the part of observers enters into the estimate of the intensity of frosts (whether light, medium, or heavy frost), it is not possible to separate accurately heavy frost from light frost. Available data show that in regions where light frosts predominate, about 40 percent of all recorded frost occurrences are light frosts, while about 60 percent are of medium intensity. In regions with considerable frost, light frosts amount to about 30-35 percent, frosts with medium intensity to about 60-65 percent, and heavy frosts to about 5 percent. In regions with a preponderance of heavy frosts, the proportion of light frosts is about 15-20 percent, frost of medium intensity about 70 percent, and heavy frost 10 percent. In regions with particularly frequent frost occurrences, for example, the Mineral'nyye Vody region, the proportion of heavy frost is as much as 15 or more percent with a correspondingly lower number of light frosts.

- 7 -

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

50X1-HUM

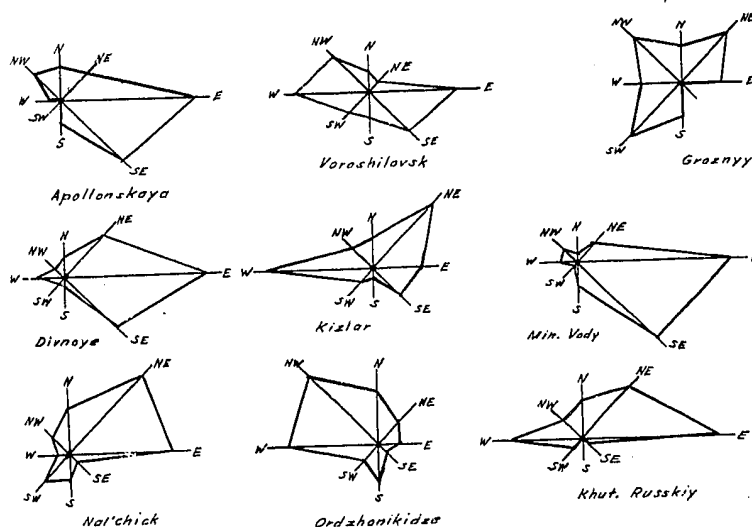
Air Temperature and Winds Under Frost Conditions

The formation of frost is chiefly observed at air temperatures of from zero to minus 5 degrees. Frost with temperatures of minus 6 to minus 7 degrees has been recorded occasionally. Observations show that most frosts are formed at temperatures from zero to minus three degrees. Air temperatures under frost conditions can be extremely low and may even approach absolute minimum temperatures. Frosts at temperatures of minus 17 to minus 18 degrees have been frequently recorded by many stations. The likelihood of extremely low temperatures is particularly great in regions with heavy frosts where the frost lasts much longer because of its intensity.

Analysis of the data on the characteristic direction and velocity of winds under frost conditions shows that the direction and velocity of winds are general for the entire area with local peculiarities according to the individual station.

The following diagram and table give the characteristic frequency of winds of various directions under frost conditions.

Probability of Various Wind Directions
Under Frost Conditions
(in percent)



- 8 -

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL
CONFIDENTIAL

50X1-HUM

Wind Direction Under Frost Conditions (in percent)

<u>Sta</u>	<u>N</u>	<u>NE</u>	<u>E</u>	<u>SE</u>	<u>S</u>	<u>SW</u>	<u>W</u>	<u>NW</u>	<u>Calm</u>
Apollonskaya	9	10	38	24	6	0	3	10	6
Voroshilovsk	5	4	26	16	7	8	20	14	11
Groznyy	10	19	11	0	9	22	11	18	10
Divnoye	5	17	40	21	3	3	8	3	0
Kizlyar	8	24	14	8	3	5	30	8	37
Mineral'nyye Vody	2	7	44	30	6	1	5	5	10
Nal'chik	12	30	29	3	7	10	3	6	12
Ordzhonikidze	15	8	6	3	10	6	25	27	7
Khutor Russkiy	10	19	38	2	0	4	20	7	9

Nine meteorological stations, located in various regions of the area, which have conducted a series of observations over 12-15 years were selected for the study of wind behavior.

As is evident from the table and diagram, most of the stations clearly show the prevalence of easterly winds and, partly, also westerly winds. However, local orographic peculiarities of the locations (e.g., influence of Caucasian mountain ranges and other elevated points, e.g., in the Groznyy region, etc.) are also pointed up by the table. These facts corroborate the theoretical conclusions of Academician B. P. Mul'tanovskiy who claims that there are two main wind currents in European USSR under frost conditions: east and west winds.

K. S. Turoverov's supposition that there are no winds in the northern and southern quarters of the horizon under frost conditions is not substantiated by the above-mentioned data. Although the proportion of northerly and southerly winds under frost conditions in most places is small, winds from these directions have been recorded at all stations.

A comparison of the pattern of wind direction under frost conditions with the monthly and seasonal wind roses shows an almost complete conformity.

There is much practical interest also in the velocity of winds under frost conditions. The following table, computed from data gathered over a 12-15 year period, shows the probability of winds of various intensity under frost conditions. The table gives only four ranges inasmuch as a more detailed breakdown with comparatively small numbers of cases would not give a more accurate picture.

Probability of Winds of Various Velocities
Under Frost Conditions
(in percent)

<u>Meteorological Sta</u>	<u>Wind Velocity (m/sec)</u>			
	<u>Calm</u>	<u>1-5</u>	<u>6-10</u>	<u>Over 10</u>
Apollonskaya	6	77	15	2
Voroshilovsk	11	38	38	13
Groznyy	9	90	1	-
Divnoye	0	35	61	4
Kizlyar	25	65	8	2
Mineral'nyye Vody	3	74	22	1
Nal'chik	12	87	1	-
Ordzhonikidze	17	83	-	-
Khutor Russkiy	9	75	15	1

The table shows that under frost conditions winds of high intensity are quite frequent in many regions, particularly in regions with heavy frosts, as in Stavropol', where winds with a velocity of over 5 meters prevail.

- 9 -

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

50X1-HUM

Average and maximum wind velocities which have been observed under frost conditions are given in the following table (in meters per second):

<u>Meteorological Sta</u>	<u>Av Wind Velocity</u>	<u>Max Wind Velocity</u>
Apollonskaya	3.4	14
Voroshilovsk	5.1	25
Groznyy	2.6	9
Divnoye	6.4	17
Kizlyar	3.1	12
Mineral'nyye Vody	4.0	14
Nal'chik	1.6	7
Ordzhonikidze	1.7	5
Khutor Russkiy	3.6	14

It should be noted that in much of the area, with the exception of shielded localities, wind velocities of up to 20 meters per second are possible under frost conditions. According to observations of the Voroshilovsk Meteorological Station, winds in the Stavropol' region, as well as in some exposed locations in the mountains, attain a velocity of even more than 20 meters per second.

The average wind velocity under frost conditions generally is very similar to the average monthly wind velocity of the region during winter.

Hoarfrost

In the study of frosts of various regions and in the determination of the possible ground frost load, the phenomena of hoarfrost must also be considered.

In the preparation of data on hoarfrost, the same criteria were utilized as for glaze frost. The same period of observation (1925 - 1939) was also utilized and all of the material was carefully checked, with doubtful or unreliable observations being excluded. The following table gives the average annual number of hoarfrost occurrences and the number of days with hoarfrost.

Average Annual Number of Hoarfrost Occurrences

Sta	No of Yr of Obs	Hoarfrost Occurrences (by months)							Total Hoar- frost Occurrences
		I	II	III	IV	X	XI	XII	
Arkhyz	8	1	0	0	0	0	0	0	1
Arzgir	15	2	2	0	0	0	0	1	5
Apollonskaya	12	6	3	2	0	0	1	4	16
Aleksandrovskaia	14	4	3	2	0	0	1	2	12
Alagir	10	5	2	1	0	0	0	3	11
Achikulak	13	2	2	1	0	0	0	1	6
Armzhi	7	0	1	0	0	0	0	1	2
Baksan	14	5	4	2	0	0	1	2	14
Blagodarnoye	15	1	2	1	0	0	1	1	6
Bogoslovskaya	8	2	1	1	0	0	0	2	6
Bol'shaya Dzhalga	14	3	2	1	0	0	0	2	8
Budennovsk	15	4	3	1	0	0	1	3	12
Vedeno	14	3	2	1	0	0	0	3	9
Voroshilovsk	15	6	5	4	0	0	2	4	21
Georgiyevsk	14	4	2	1	0	0	1	3	11
Groznyy	15	3	2	1	0	0	0	1	7

- 10 -

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

50X1-HUM

Sta	No of Yr of Obs	Hoarfrost Occurrences (by months)								Total Hoar- frost Occurrences				
		I	II	III	IV	X	XI	XII						
Gudermes	11	2	1	1	0	0	0	1	5					
Divnoye	15	3	2	1	0	0	0	1	7					
Dargavs	14	1	3	1	0	0	1	1	7					
Digora	12	4	1	1	0	0	1	3	10					
Yessentuki	15	5	4	3	0	0	1	4	17					
Zheleznovodsk	9	5	4	4	1	0	1	4	19					
Zolotushka	13	5	4	5	1	0	1	4	20					
Zamankul	12	4	3	1	0	0	1	2	11					
Ipatovo	14	2	0	1	0	0		1	4					
Kian	12	6	3	2	0	0	1	3	14					
Kizlyar	13	1	1	1	0	0	1	1	5					
Kislovodsk	15	2	1	1	0	0	1	2	7					
Kotlyarevskaya	13	6	3	3	0	0	1	4	17					
Kursavka	14	5	4	3	0	0	1	3	16					
Mikoyan-Shakhar	8	3	1	1	0	0	1	2	8					
Mineral'nyye Vody	15	6	4	2	0	0	1	3	16					
Mozdok	11	4	2	1	0	0	0	2	9					
Molotovskoye	15	1	1	1	0	0	0	1	4					
Mikhaylovskaya	9	9	6	2	0	0	1	5	23					
Murtazovo	13	6	3	2	0	0	0	3	14					
Naurskaya	15	2	1	1	0	0	0	2	6					
Nevinomysskaya	15	3	1	1	0	0	0	0	5					
Nizhniy Uchkulan	8	0	0	0	0	0	0	0	0					
Novo-Aleksandrov- skaya	12	2	1	1	0	0	0	1	5					
Novoselitskoye	14	3	3	2	0	0	1	3	12					
Nizhniy Zaromag	9	0	0	1	0	0	0	0	1					
Fort Nazran'	8	6	2	2	0	0	1	4	15					
Nal'chik	15	8	4	5	0	0	1	5	23					
Ol'gino	15	6	5	3	0	0	1	3	18					
Ordzhonikidze	15	3	3	1	0	0	0	2	9					
Petrovskoye	15	1	0	1	0	0	0	1	3					
Pyatigorsk	15	6	4	2	0	0	1	4	17					
Prokhladnaya	15	4	4	2	0	0	1	3	14					
Stepan Bugor	11	4	3	1	0	0	0	1	9					
Sleptsovskaya	15	3	2	1	0	0	1	2	9					
Tambukanskoye Lake	13	4	3	2	0	0	1	3	13					
Teberda	15	1	1	0	0	0	1	1	4					
Tempel'gof	12	4	3	1	0	0	1	3	12					
Terekli Mekteb	12	1	1	1	0	0	0	2	5					
Trunovskaya	15	2	2	1	0	0	0	1	6					
Usengi	11	0	1	1	1	0	1	1	5					
Fasnal	8	0	1	1	0	0	1	0	3					
Khutor Russkiy	15	3	3	2	0	0	1	2	11					
Tsey	10	0	0	1	0	0	0	0	1					
Cherkessk	12	5	3	1	0	0	1	4	14					
Shatoy	14	2	0	0	0	0	0	2	4					
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Bermamyt	6	5	5	6	7	3	1	0	0	2	1	4	5	39
Mamisson Pass	8	8	9	10	10	4	2	0	0	2	6	7	12	73
El'brus	7	4	3	5	5	4	3	1	1	3	5	4	6	44

- 11 -

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

50X1-HUM

Sta	No of Yr of Obs	No of Days With Hoarfrost (by months)							Total Hoar- frost Occurrences
		I	II	III	IV	X	XI	XII	
Arkhyz	8	1	0	0	0	0	0	0	1
Arzgir	15	3	2	0	0	0	0	1	6
Apollonskaya	12	10	4	3	0	0	1	5	23
Aleksandrovskaya	14	7	4	2	0	0	1	4	18
Alagri	10	8	2	1	0	0	0	6	17
Achikulak	13	3	2	1	0	0	0	2	7
Armghi	7	0	1	0	0	0	0	1	2
Baksan	14	11	7	4	0	0	1	6	29
Blagodarnoye	15	1	1	1	0	0	1	2	6
Bogoslovskaya	8	2	1	1	0	0	0	2	6
Bol'shaya Dzharga	14	4	2	1	0	0	0	3	10
Budennovsk	15	5	4	1	0	0	1	3	14
Vedeno	14	5	3	2	0	0	0	5	15
Voroshilovsk	15	10	6	5	0	0	4	8	35
Georgiyevsk	14	8	3	1	0	0	1	5	18
Groznyy	15	4	3	1	0	0	0	2	10
Gudermes	11	2	1	1	0	0	0	2	6
Divnoye	15	5	2	2	0	0	0	2	11
Dargavs	14	2	3	2	1	0	1	1	10
Digora	12	7	2	1	0	0	1	6	17
Yessentuki	15	2	8	4	0	0	1	7	32
Zheleznovodsk	9	18	11	7	2	0	3	9	50
Zolotushka	13	16	10	7	1	0	2	9	45
Zamankul	12	7	3	1	0	0	1	3	15
Ipatovo	14	3	1	1	0	0	0	2	7
Klan	12	7	4	2	0	0	1	3	17
Kizlyar	13	2	1	2	0	0	1	1	7
Kislovodsk	15	3	1	1	0	0	1	2	8
Kotlyarevskaya	13	9	6	4	0	0	1	6	26
Kursavka	14	13	5	3	0	0	1	6	29
Mikoyan-Shakhar	8	4	1	1	0	0	1	2	9
Mineral'nyye Vody	15	10	6	2	0	0	1	5	24
Mozdok	11	6	3	1	0	0	0	3	13
Molotovskoye	15	1	1	1	0	0	0	1	4
Mikhaylovskaya	9	11	6	2	0	0	1	7	27
Murtazovo	13	7	3	2	0	0	0	3	15
Naurskaya	15	3	2	1	0	0	0	3	9
Nevinnomysskaya	15	3	1	1	0	0	0	1	6
Nizhniy Uchkulan	8	0	0	0	0	0	0	0	0
Novo-Aleksandrovskaya	12	2	1	1	0	0	0	1	5
Novoselitskoye	14	8	5	3	0	0	1	6	23
Nizhniy Zaromag	9	0	0	1	0	0	0	0	1
Fort Nazran'	8	11	4	3	0	0	2	9	29
Nal'chik	15	12	6	6	0	0	2	7	33
Ol'gino	15	8	6	3	0	0	1	5	23
Ordzhonikidze	15	7	4	2	0	0	0	5	18
Petrovskoye	15	1	0	1	0	0	0	1	3
P'yatigorsk	15	12	7	3	0	0	1	6	29
Prokhladnaya	15	8	6	2	0	0	1	5	22
Stepan Bugor	11	5	3	1	0	0	0	3	12
Sleptsovskaya	15	5	2	1	0	0	1	3	12
Tambukanskoye Lake	13	14	10	4	0	0	2	6	36
Teberda	15	1	1	0	0	0	1	1	4
Tempel'gof	12	7	4	1	0	0	1	4	17
Terekli Mekteb	12	2	1	1	0	0	0	2	5
Trunovskaya	15	3	2	1	0	0	0	2	8

- 12 -

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL.

50X1-HUM

Sta	No of Yr of Obs	No of Days With Hoarfrost (by months)								Total Hoar- frost Occurrences
		I	II	III	IV	X	XI	XII		
Usengi	11	0	1	1	1	0	1	1	5	
Fasnal	8	1	1	1	0	0	1	1	5	
Khutor Russkiy	15	7	4	2	0	0	1	5	19	
Tsey	10	0	0	1	0	0	0	0	1	
Cherkessk	12	8	4	1	0	0	1	5	19	
Shatoy	14	2	0	0	0	0	0	2	4	

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		
Bermamyt	6	7	9	8	11	4	1	0	0	3	2	6	7	58
Mamisson Pass	8	11	11	11	12	4	3	0	0	6	7	10	14	89
El'brus	7	4	3	5	5	5	3	1	1	4	7	8	8	54

Note: 0.5 and fewer occurrences of frost are rounded to zero.

The above data show that the intensity of hoarfrosts in the area fluctuated widely. In the extreme northwest along an easterly line from Divnoye, Budennovsk, Groznyy, Ordzhonikidze, Dargavs, and, to a considerable extent, also in the mountains, the annual number of days with hoarfrost averages fewer than ten. The high-mountain stations show a much larger number of days with hoarfrost (El'brus, 54; Mamisson Pass, 99; Bermamyt, 58). More than 20 days with hoarfrost are observed within the polygon bounded by the line Kursavka - Novoselitskoye - Ol'gino - Kotlyarevskaya - Nal'chik - Yessentuki, and also in the region of Voroshilovsk.

In most places, hoarfrost is observed from November to April, with the maximum number of days occurring in January. When the winter is mild, hoarfrost frequently does not occur in November and April.

In high-mountain regions, hoarfrost can be observed all year round. The maximum number of occurrences is generally between December and February.

The following table indicates the maximum number of hoarfrost occurrences and days with hoarfrost for all the periods for which observations were made.

Maximum Annual Hoarfrost Occurrences and Days With Hoarfrost

Sta	Hoarfrost Occurrences	Days With Hoarfrost	Sta	Hoarfrost Occurrences	Days With Hoarfrost
Arkhyz	5	5	Kotlyarevskaya	28	46
Arzgir	14	19	Kursavka	23	43
Apollonskaya	30	38	Mikoyan-Shakhar	23	25
Aleksandrovskaya	26	30	Mineral'nyye Vody	33	50
Alagri	22	23	Mozdok	20	30
Achikulak	14	18	Molotovskoye	9	10
Armkhi	17	19	Mikhaylovskaya	47	55
Baksan	24	54	Murtazovo	25	27
Blagodarnoye	11	12	Naurskaya	11	14
Bogoslovskaya	11	13	Nevinnomyskaya	12	12
Bol'shaya Dzhalga	22	23	Nizhniy Uchkulan	3	3
Budennovsk	25	30	Novo-Aleksandrovskaya	15	15

- 13 -

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

50X1-HUM

<u>Sta</u>	<u>Hoarfrost Occurrences</u>	<u>Days With Hoarfrost</u>	<u>Sta</u>	<u>Hoarfrost Occurrences</u>	<u>Days With Hoarfrost</u>
Vedeno	22	29	Novoselitskoye	24	47
Voroshilovsk	43	81	Nizhniy Zaromag	4	4
Georgiyevsk	18	28	Fort Nazran'	20	40
Groznyy	17	22	Nal'chik	38	60
Gudermes	11	13	Ol'gino	32	47
Divnoye	17	28	Ordzhonikidze	18	37
Dargavs	15	19	Petrovskoye	8	9
Digora	22	33	Pyatigorsk	36	55
Yessentuki	34	48	Prokhladnaya	35	52
Zheleznovodsk	31	79	Stepan Bugor	26	38
Zolotushka	38	72	Sleptovskaya	15	23
Zamankul	31	31	Tambukanskoye Lake	30	56
Ipatovo	12	18	Teberda	7	10
Kian	28	32	Tempel'gof	32	42
Kizlyar	18	22	Terekli Mekteb	12	12
Kislovodsk	15	18	Trunovskaya	7	13
Usengi	5	6	Shato'y	11	12
Fasnal	7	11	Bermamyt	52	68
Khutor Russkiy	22	38	Mamisson Pass	133	140
Tsey	4	4	El'brus	106	129
Cherkessk	27	38			

Hoarfrost formation is observed at below zero temperatures, sometimes as low as 10 to 20 degrees below zero. Hoarfrost has been observed at close to absolute minimum air temperatures.

The following average and maximum wind velocities have been recorded under hoarfrost conditions:

Wind Velocity (in meters per second)

	<u>Av</u>	<u>Max</u>
Divnoye	3.4	12
Voroshilovsk	4.6	14
Kizlyar	1.5	10
Mineral'nyye Vody	2.9	12
Nal'chik	1.4	10

Maximum velocity which has been observed under hoarfrost does not exceed 14 meters per second. In working out data on hoarfrost density, several stations have recorded wind velocities of 16-17 meters per second. These figures prove that in some cases hoarfrost does not appear in its pure form but as a mixture which is more stable and which maintains itself under wind velocities of more than 14 meters per second.

Observations of meteorological stations confirm the fact that hoarfrost deposits form mainly on those portions of objects which are exposed to the wind. The probability of various wind directions are given in the following table.

- 14 -

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

50X1-HUM

Wind Direction Under Hoarfrost Conditions
(in percent)

Sta	N	NE	E	SE	S	SW	W	NW	Calm
Divnoye	5	13	37	19	5	5	10	6	9
Voroshilovsk	3	7	43	30	4	3	5	5	12
Kizlyar	6	12	11	11	2	6	36	16	21
Mineral'nyye Vody	2	6	48	26	6	6	4	2	12
Nal'chik	7	9	2	3	17	35	5	2	11

Intensity of Frosts

In calculating possible ground frost load, one must know the intensity of frost, i.e., the thickness of the deposit and the specific gravity of the frost formation. The thickness of the frost can be determined by letting a 5-millimeter wire freeze. The intensity of frost formation is then measured by the thickness of the deposit of the 5-millimeter wire, allowing for the diameter of the frozen 5-millimeter wire.

To indicate the intensity of frost formation, use has been made of: meteorological station data obtained between 1937 and 1941; observation data on frost for 1923 - 1933 cited by N. S. Muretov; independent measurements carried out by communication and power organizations, obtained as a result of a study of damage to communication and electric power lines during 1930 - 1941; other observation data. In view of the heterogeneity of the measurements, the only figures on thickness quoted are those which have been carefully substantiated. Figures not considered completely accurate are rounded and are presented in the table as the lower limit of the observed maximum thickness of frost deposit.

Observed Maximum Intensity of Frost Deposit
(in millimeters)

Apollonskaya	43	Kursavka	51
Baksan	over 30	Mineral'nyye Vody	127
Blagodarnoye	over 40	Mozdok	over 20
Budennovsk	47	Nevinnomysskaya	11
Vedeno	over 10	Novo-Aleksandrovskaya	13
Voroshilovsk	70	Ordzhonikidze	29
Georgiyevsk	over 30	Prokhladnaya	73
Groznyy	54	Pyatigorsk	over 100
Gudermes	29	Ryzdvyanaya	over 40
Divnoye	74	Sleptsovskaya	20
Izobil'noye	over 50	Terekil Mekteb	17
Kian	30	El'brus	71

(All figures allow a diameter of 5 millimeters for the frost-covered wire.)

Data obtained from the frost-covered wire show that the range of the specific gravity of the glaze frost formation fluctuates between 0.17 and 0.89. It must be noted, however, that glaze frost formations with a specific gravity of less than 0.3 are most often not pure frost but a mixture, which is frequently recorded by observers as frost. The same observations also show that the specific gravity of hoarfrost falls, for the most part, within a range of 0.01 to 0.18.

Thus, the specific gravity for glaze frost is between 0.3-0.89; for the mixture, 0.1-0.3; and for hoarfrost, 0.01-0.18.

- 15 -

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

50X1-HUM

These figures conform to the data collected at the Pyatigorsk Frost Research Station, cited by K. S. Turoverov in his work.

The specific gravity of the most intense frosts observed during the past years falls within the limits of 0.47 to 0.89. Greater specific gravities are recorded in the region of Voroshilovsk, Mineral'nyye Vody, Groznyy, Nal'chik, Baksan and Mozdok.

The lack of series of reliable observations precludes calculation of the frequency of various ranges of specific gravity as well as computations of the average and maximum value of specific gravity for each station. It is likewise not possible to express in percent relationships between various increases in specific gravity of deposits on wires placed at right angles to the wind. The observed data do not yield absolute indexes and frequently similar observations give different results. It is only possible to establish with certainty the fact that the deposit frost on the wires placed at right angles to the wind direction is often 20-25 percent greater than on wires placed at a very sharp angle to the wind direction. In regard to hoarfrost, observations confirm the fact that a considerably larger deposit of hoarfrost is observed on wires which are placed at right angles to the wind direction.

Regions With Frost Occurrences

In order to divide the area according to the degree of glaze frost occurrence and for the best possible use of the observed data, the basic criteria utilized in determining various glaze characteristics is very important. Unfortunately, up to the present there are no universal indexes for determining characteristics of glaze frost distribution and extent.

N. S. Muretov in his work took as a so-called combined value the duration and the intensity of glaze frost. A map of glaze frost expectancy in regions with railroads has been drawn up, based on Muretov's combined value. Muretov's combined value is broken down in the following table:

Group	Max Intensity (mm)	Duration (days)	Max Intensity (mm)	Duration (days)	Max Intensity (mm)	Duration (days)
I	15	1	-	-	-	-
II	15	1 - 3	15 - 49	1	-	-
III	15	3	15 - 49	1 - 3	50 and over	1
IV	-	-	15 - 49	3	50 and over	1 - 3
V	-	-	-	-	50 and over	3

There are RSFSR norms for mechanical computations which combine all observed types of frost formations under the general name of frost, setting up the following classification of regions in the process:

Region 0 - Frost not observed.

Region 1 -- Regions with average intensity of frost formation; thickness of frost 10 millimeters; specific gravity 0.9.

Region 2 -- Regions with heavy frosts; thickness of 20 millimeters; specific gravity 0.5.

Region 3 -- Regions with very heavy frosts; thickness of frost 30 millimeters; specific gravity 0.5.

- 16 -

CONFIDENTIAL

CONFIDENTIAL

~~CONFIDENTIAL~~

CONFIDENTIAL

50X1-HUM

Norms for planning the construction of the mechanical sections of high-tension power lines, approved in 1940 by the Technical Council of the People's Commissariat of Electric Power Plants and the Electrical Industry, provide the following data:

Region I -- Characterized by a thickness of frost of 0.5 centimeter; a specific gravity of 0.9; and winds of 15 meters per second.

Region II -- Characterized by a thickness of frost of 1 centimeter; a specific gravity of 0.9; and winds of 15 meters per second.

Region III -- Characterized by a thickness of frost of 1.5 centimeter; a specific gravity of 0.9; and winds of 20 meters per second.

Region IV -- Characterized by a thickness of frost sheet of 2 centimeters; a specific gravity of 0.9; and winds of 20 meters per second.

Without going into the merits or shortcomings of the above classifications, one must note that the principal question of interest to planning and construction organizations is the maximum possible ground frost load under glaze frost conditions. Therefore, in determining the extent of frost of regions, it is most important to observe the intensity of the frost formation and the velocity of winds observed under frost conditions.

Frequency of glaze frost phenomena is also of considerable interest in solving mining and related problems. Observed data were used to establish the boundaries of regions with glaze frosts. Boundaries of regions were drawn up with regard to the topography, inasmuch as observation confirmed the close relationship existing between the extent of frost occurrence and the nature of the topography. In analyzing the data, it was repeatedly observed that two adjacent points under similar conditions but located on different terrain features give different figures not only for intensity of deposit, but also for frequency of frost occurrence. This is especially true of mountainous country exposed to those winds which prevail under frost conditions.

The sheltered positions of some meteorological stations located among buildings also considerably reduces the intensity of frosts. A good example of the importance of location was the difference in the intensity of frost observed in Rostov-on-Don on 7 December 1941. According to measurements conducted by the Rostov Geophysical Observatory, the frost intensity reached 34 millimeters. The Rostov Hydrometeorological Station, located on the left, lower bank of the Don River, gave a maximum intensity of 12 millimeters for the same frost. According to the author's observations in Rostov, the intensity of the frost fluctuates from 1-2 millimeters to 15-20 millimeters. The most intense deposit of frost was observed on wires crossing streets and running parallel to the wind direction.

The Caucasus Meteorological Station, located among railroad installations, gives a maximum intensity of 10-13 millimeters for the period 1938 - 1941, whereas during the same period the Caucasus region suffered repeated damage to its power lines as a result of frost deposits. The same thing is noted in Mozdok, Nal'chik and other populated places.

The distance of wires from the ground is of considerable significance in estimating the intensity of frost. Similar observations by several meteorological stations, conducted on frost-covered wires two and six meters above the ground, show that the intensity of frost deposits increases with the height. The paucity of the observed data does not permit definite conclusions as to the magnitude of the increase; however, it is considerable.

- 17 -

CONFIDENTIAL

~~CONFIDENTIAL~~

CONFIDENTIAL

CONFIDENTIAL

50X1-HUM

Observations made by communications workers on the North Caucasus Railroad show much lighter frost deposits on wires near shelter belts. It must be kept in mind that shelter belts create disturbances in the normal direction of the air current and in some cases may even diminish the wind velocity. This fact should be considered in planting shelter belts in regions of most intensive frost formation. Shelter belts may become measures against the wrecking of power lines by intense frost.

In conformity with the classification which has been used in the following map of frost, the area is divided into the following five regions:

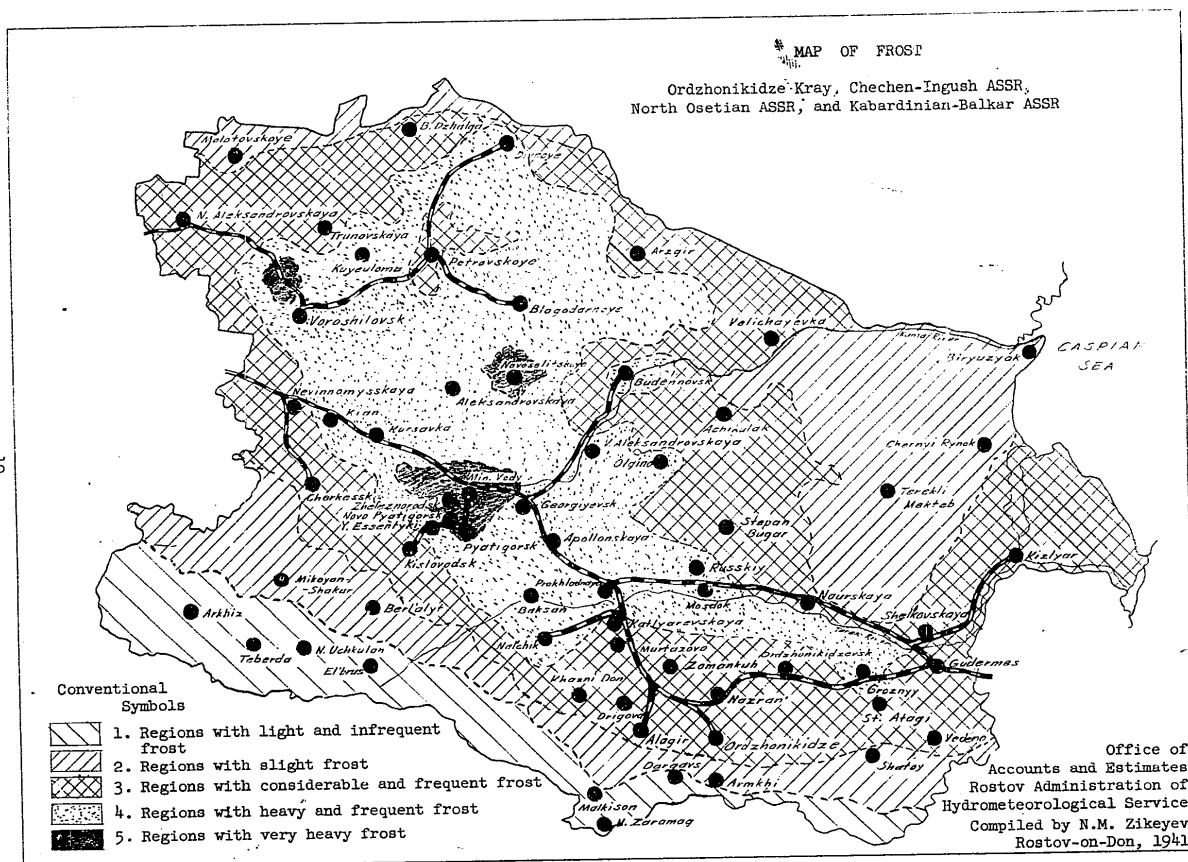
1. Light and infrequent frosts where the intensity of frost formation amounts to only a few millimeters.
2. Slight frosts. Intensity for a 5-millimeter wire does not exceed 20 millimeters; the wind velocity is up to 10-15 meters per second.
3. Considerable and frequent frost. Intensity up to 30 millimeters; winds more than 15 miles per second.
4. Heavy and frequent frost. Intensity up to 50 millimeters; strong winds (18-20 meters per second), high specific gravity (0.6-0.9); intensity up to 100 millimeters; low specific gravity (0.3-0.5).
5. Very heavy frosts. Possible intensity of more than 100 millimeters; winds of 18 and more meters per second.

The map of frost represents the first experiment in dividing an area into regions according to frost prevalence. In using the map, certain schematic conventions must be kept in mind. For example, individual localities in regions of considerable frost may show frosts of lesser intensity because of some local peculiarities. A similar situation also holds true for some localities which show a great deal of frost although located in regions of little frost. This is especially applicable to mountainous regions where there are generally only light frosts, but where peaks and slopes show a considerably greater intensity of frost deposit.

- 18 -

CONFIDENTIAL

CONFIDENTIAL



CONFIDENTIAL

CONFIDENTIAL

50X1-HUM

Further systematic study of frost formation, improved quality in the observations for determination of the intensity of frost formation, and additional information on representative distribution of frosts will make possible an even more detailed map of frost and will allow more concrete scientific conclusions and generalizations.

BIBLIOGRAPHY

- A. Vegenev, Thermodynamics of the Atmosphere, 1935.
- N. S. Muretov, Glaze Frost and Hoarfrost in the Vicinity of Railroads, Railroad Transportation Publishing House, Moscow, 1935.
- K. S. Tureverov, "Analyzing Existing Methods of Calculating Frost and Wind Direction," Journal Meteorologiya and Hydrologiya, No 7-8, 1939.
- V. Dezhordzhio - "Glaze Frost Between 13 - 16 December 1930 in the Area of the Krasnodar Railroad, Journal Geofizika, No 3, 1933.
- B. P. Mul'tanovskiy, The Question of Forecasting Frost in European Russia. Volume XIX of the Council of Chiefs of Communication and Electrification, 1933.
- N. T. Zikeyev, Glaze Frost in Rostov Oblast and Krasnodar Kray, Rostov, 1940.
- N. T. Zikeyev, Glaze Frost in Stalingrad Oblast and Kalmyk ASSR, Rostov, 1940.

- E N D -

- 20 -

CONFIDENTIAL

CONFIDENTIAL